

PATENT SPECIFICATION

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DRAWINGS ATTACHED



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(54) IMPROVED TIMER CIRCUIT

(71) We, AMERICAN STANDARD INC., a corporation organised and existing under the laws of the State of Delaware, United States of America, of 40 West 40th Street, New York, New York 10018, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved timer circuit particularly, though not exclusively, responsive to a proximity device for controlling the flow of water through a plumbing fixture such as a urinal. More specifically, this invention relates to an electronic timing circuit responsive to a urinal proximity circuit for flushing water through a plumbing fixture, such as a urinal, after each use.

Most conventional urinals are generally flushed by the user manually by operating a valving device. However, since many users are careless and do not operate the valving device, unpleasant odours and unsanitary conditions are prevalent and distasteful in public comfort stations and washrooms. In order to alleviate such conditions, some public urinals are periodically flushed at given timed intervals. While this minimizes the odour and the sanitary problems, there results a considerable and unnecessary waste of precious water.

Plumbing fixtures utilising proximity control devices have heretofore been proposed, and it was suggested that they employ timing devices to regulate the cycle and flow of water during the flushing operation. The timing devices of such suggested arrangements generally employ motor-driven timers or complex electronic circuitry which are responsive to the proximity sensing circuitry for operating a solenoid controlled flush valve. Some of these earlier timing devices suffer from the disadvantage of being temperature and voltage sensitive, and the preset timing interval varies considerably under

different operating conditions. Moreover, due to their complexity and variability, these prior circuits have been found to be unreliable in operation and costly to maintain.

The present invention is a timer circuit including a normally charged capacitor, a proximity circuit, means responsive to the operation of the proximity circuit to allow discharge of said capacitor, means responsive to the release of the proximity circuit to recharge the capacitor, a transistor device coupled to said capacitor means and being rendered conductive only after a first predetermined interval after the release of said proximity circuit, a load circuit coupled to said transistor device and operated when said transistor device is rendered conductive, said operation of said load circuit lasting only for a predetermined time interval after said transistor device is rendered conductive, whereupon said transistor device will become non-conductive.

The timer circuit may be for operating a solenoid flush valve in response to the operation of a proximity circuit of a plumbing fixture, the capacitor may be coupled to said proximity circuit for providing a forward bias to said transistor device signal after each cycle of operation of said proximity circuit, and a relay may be coupled to the output on said transistor device for connecting power to said solenoid valve, said relay being energised while said amplifier is forward biased.

The foregoing and further features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawing which discloses a preferred embodiment of the present invention. Although the drawing and the accompanying description may be directed toward the control and operation of a plumbing fixture, such as a urinal, it will be understood that the invention is equally applicable to other plumbing fixtures and to other control apparatus for other types of equipment.

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The drawing discloses an electrical schematic diagram of the timer arrangements.

Referring to the drawing, there is shown a proximity sensing circuit 42 coupled through coaxial cable 45 to the so-called antenna 44 which may be located adjacent to or behind the plumbing fixture (not shown). Antenna 44 generally may comprise a flat sheet of metal and may be isolated from grounded objects to the rear by a shield 43 connected to the coaxial shield of cable 45. Proximity sensing circuit 42 may be of any suitable or well known type and may consist of any conventional circuit capable of detecting small changes in capacitance between antenna 44 and ground. Such changes are commonly brought about by the approach of a person to within a close proximity to antenna 44.

Coupled to the output of proximity circuit 42 is a relay having a coil 38. The relay also includes contact arm 39 which is shown in electrical contact with a back terminal 40 when coil 38 is de-energised.

The timing circuit 10 includes rectifier 28 coupled in series through resistor 29 and contact arm 39 to a conventional AC power source 11. Coupled to the positive output of diode 28 at terminal 49 is a storage capacitor 15 and the series combination of a resistor 19 and Zener diode voltage regulator 14. Capacitor 15 and resistor 19 serve as a half-wave rectifier filter so that terminal 50 may be maintained at a fixed and constant potential.

During the standby operation of the proximity circuit when relay 38 remains de-energised, the capacitor 15 may be charged from source 11 over the circuit including the contact arm 39, contact 40, resistor 29 and diode 28. At the same time the DC potential at terminal 50 applies a charge through a resistor 18 to a capacitor 16 and through the path formed by the series combination of resistor 18, a capacitor 17, and a resistor 21 to the base to emitter resistance of a transistor 13. Capacitor 16 is charged to a DC potential which is momentarily less than the potential of terminal 50 due to the potential drop across resistor 18. Capacitor 17 is also charged to a DC potential which is momentarily less than the potential of terminal 50 due to the potential drop across resistors 18 and 21 caused by the current flowing through resistors 18 and 21 and the forward bias resistance of the base emitter junction of transistor 13. Capacitors 24 and 27, which are connected to each other by a diode 25 and which are coupled through resistors 23 to potentiometer 22, receive substantially no charge during standby due to the low potential of the base to emitter voltage of transistor 13. The collector of transistor 13 is connected through

the parallel path of winding of relay coil 35 and capacitor 32 to the terminal 50. Relay coil 35 controls a normally open contact arm 36 for connecting power source 11 to a flush valve solenoid 12. In the standby position, the base of transistor 13 is biased so as to cut off the flow of current through the collector of transistor 13 so that relay coil 35 remains de-energised. In this connection, it will be observed that the base of the transistor is connected to the emitter by the series circuit of resistors 21 and 22.

When a person approaches the area of antenna 44, circuit 42 will cause relay coil 38 to be energised to actuate contact arm 39. Contact arm 39 will close upon contact 41 and disconnect contact 40 from power source 11. Power source 11 will thereupon be connected through contact 41 and resistor 30 to light neon indicator lamp 31. Capacitor 15 will then discharge through resistors 19 and 34. Capacitor 16 will discharge through two paths, one including resistors 18 and 34 and the other including diode 33 and resistor 34. Capacitor 17 will also discharge through the parallel circuit of diode 33 and resistor 18 and through resistor 34 and diode 20. Transistor 13 will remain non-conducting during the priming of proximity circuit 42. The priming interval of circuit 42 represents the first delay interval of a predetermined duration.

By design, the time required to prime circuit 42, that is, the first delay interval, has been set to a minimum time interval, such as five to ten seconds, or until the withdrawal of the person from antenna 44, whichever is longer. Hence, after a person has left the premises of antenna 44, relay coil 38 will become de-energised and will connect terminal 40 to source 11 and complete the circuit to recharge capacitor 15. Capacitor 16 will also be recharged but at a slower rate due to the additional resistance of resistors 18. Moreover, capacitor 17 will recharge slowly through resistor 18.

The sudden application of potential to terminal 50 after a person leaves the scene of antenna 44 will cause the charge current to capacitor 17 to rise to a peak value of, for example, 45 microamperes in a predetermined time interval, or in what may be termed a second delay interval, of, for example, one second which current will be sufficient to "turn on" or render conductive the transistor 13 and cause current to flow to energise relay coil 35 and operate contact arm 36. When the adjustable arm of potentiometer 22 is set at ground level, the charging current of capacitor 17 will decay to, for example, 10 microamperes in approximately 25 seconds. Relay coil 35 will then release contact arm 36 and disconnect power source 11 from solenoid 12.

The drop out of relay coil 35 is made stable by utilising the base to emitter voltage of transistor 13 as a threshold potential. This threshold potential is not significantly temperature sensitive so that even for large temperature changes of, for example, 25°F, a change of only two seconds results in the flush time, when the total flush time, that is, the third delay interval, is initially set for about 25 seconds.

While relay contact arm 36 is closed upon contact 37 power source 11 will also be connected across a voltage doubling circuit consisting of diodes 25 and 26 and capacitors 24 and 27. The output of the voltage doubler is applied through resistor 23 and potentiometer 22 and coupled to the base of transistor 13 through resistor 21. The voltage doubler provides a negative bias potential through potentiometer 22 to the base of transistor 13. By moving the adjustable arm of potentiometer 22 upward, additional negative bias may be provided to the base of transistor 13 to reduce the time delay provided by circuit 10. The adjustment of the time delay by potentiometer 22 and its related circuitry controls the flushing time, that is, the third delay interval, of solenoid 12.

One of the features of this invention involves a safety factor in the operation of relay 35 from the collector circuit of transistor 13 so that the operation of relay 35 will be independent of variations in the gain of the transistor. This safety factor is achieved by supplying substantially more current to the base of transistor 13 than the minimum required to pull in relay 35. In a particular embodiment of the invention, a safety factor of two was used. This excess base current is always present at the instant that

relay 35 pulls in, regardless of the setting of potentiometer 22. The reverse bias potential controlled by potentiometer 22 is generated only after relay 35 has operated to connect the power source 11 to the above-noted voltage doubling circuit.

After the base current of transistor 13 drops below, for example, 10 microamperes and contact arm 36 opens, the base of transistor 13 remains negatively biased for a predetermined interval of, for example, approximately two seconds, due to the RC time delay caused by resistor 23 and capacitor 24. At the end of a flush cycle, this time delay prevents the input current of transistor 13 from actuating contact arm 36. After a short flush cycle, the discharge current of capacitor 17 will otherwise be high enough to turn transistor 13 on again after the relay contact 36 opens.

To maintain a high reliability of operation of circuit 10, capacitors 15, 16 and 17, which are preferably electrolytic capacitors, remain charged during the standby period of operation and are only discharged after circuit 42 is primed. Capacitors 24 and 27 are preferably non-electrolytic because they must remain discharged except during the operation of relay coil 35. The voltage doubling circuit formed by capacitors 24 and 27 and diodes 25 and 26 serve also as a transient voltage arrestor to limit the high transient voltage which occurs when contact 36 is opened and solenoid 12 becomes interrupted. This prevents any high voltage transients from appearing across solenoid 12, and reduces arcing and resulting shortened life in contact set 36 and 37.

In an actual embodiment of the timer circuit, the following component values were used.

ELEMENT NUMBER	COMPONENT	VALUE
	AC Power Source	115 volts, 60 cycles
	Silicon Transistor	2N3392
5	Zener Diode (18 v.)	GE 24XL1813
	Electrolytic capacitor	10 uf, 150 v.
	Electrolytic capacitor	50 uf, 25 v.
	Electrolytic capacitor	50 uf, 25 v.
	Resistor— $\frac{1}{2}$ watt	68,000 ohms
10	Resistor— $\frac{1}{2}$ watt	10,000 ohms (1 watt)
	Resistor— $\frac{1}{2}$ watt	68,000 ohms
	Resistor— $\frac{1}{2}$ watt	10 megohms
	Resistor— $\frac{1}{2}$ watt	1,500 (1 watt)
	Resistor— $\frac{1}{2}$ watt	33,000 ohms
	Resistor— $\frac{1}{2}$ watt	27,000 ohms
15	Potentiometer	2,000,000 ohms
	Diode	25 v.
	Diode	400 v.
	Diode	400 v.
20	Diode	400 v.
	Diode	25 v.
	FILM capacitor	0.22 uf, 400 v.
	FILM capacitor	0.01 uf, 400 v.
	FILM capacitor	0.01 uf, 400 v.

25 WHAT WE CLAIM IS:—

1. A timer circuit including a normally charged capacitor, a proximity circuit, means responsive to the operation of the proximity circuit to allow discharge of said capacitor, means responsive to the release of the proximity circuit to recharge the capacitor, a transistor device coupled to said capacitor means and being rendered conductive only after a first predetermined interval after the release of said proximity circuit; a load circuit coupled to said transistor device and operated when said transistor device is rendered conductive, said operation of said load circuit lasting only for a predetermined time interval after said transistor device is rendered conductive, whereupon said transistor device will become non-conductive.

2. A timer circuit as claimed in claim 1, in which the capacitor is an electrolytic capacitor.

3. A timer circuit as claimed in claim 1 or claim 2 in which the means for operating the load circuit includes a voltage doubler circuit interconnecting the load to the transistor device.

4. A timer circuit as claimed in claim 1 for energising a solenoid flush valve in response to the operation of a proximity circuit of a plumbing fixture, in which the capacitor is coupled to said proximity circuit for providing a forward bias to said transistor device after each cycle of operation of said proximity circuit, and a relay is coupled to the output of said transistor de-

vice for connecting power to said solenoid valve, said relay being energised while said amplifier is forward biased.

5. A timer circuit as claimed in claim 4, including reverse bias means responsive to the energisation of said solenoid valve, and means for coupling said reverse bias means to the input of said transistor device.

6. A timer circuit as claimed in claim 5, wherein said means for coupling is a potentiometer for adjusting the magnitude of said reverse bias to control the duration of operation of said solenoid valve.

7. A timer circuit as claimed in claim 6, wherein said reverse bias means comprises a voltage doubling circuit coupled across said solenoid valve.

8. A timer circuit as claimed in claim 7, wherein said voltage doubling circuit additionally comprise delay means for maintaining said reverse bias for a short time interval after said solenoid valve becomes de-energised.

9. A timer circuit as claimed in claim 8, wherein said delay means comprises an RC network.

10. A timer circuit substantially as hereinbefore described with reference to the accompanying drawing.

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